09/647081

410 Rec'd PCT/PTO 26 SEP 2000

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
REQUEST FOR FILING NATIONAL PHASE OF
PCT APPLICATION UNDER 35 U.S.C. 371 AND 37 CFR 1.494 OR 1.495

To: Asst. Commissioner of Patents and Trademarks
Washington, D.C. 20231

(Our Deposit Account No. 03-3975

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US)

Atty Dkt: **PM** 273843 /T298020US
M# /Client Ref.

From: Pillsbury Madison & Sutro LLP, IP Group:

Date: September 26, 2000

This is a **REQUEST** for **FILING** a PCT/USA National Phase Application based on:

1. International Application	2. International Filing Date	3. Earliest Priority Date Claimed
PCT/FI99/00247	25 MAR 1999	27 MAR 1998
⇧ country code	Day MONTH Year	Day MONTH Year (use item 2 if no earlier priority)

4. Measured from the earliest priority date in item 3, this PCT/USA National Phase Application Request is being filed within:

(a) ☐ 20 months from above item 3 date (b) ☒ 30 months from above item 3 date,

(c) Therefore, the due date (unextendable) is September 27, 2000

5. Title of Invention METHOD OF TRANSMITTING SYNCHRONIZED CHANNEL IN RADIO TRANSMITTER

6. Inventor(s) RANTALAINEN, Timo et al

Applicant herewith submits the following under 35 U.S.C. 371 to effect filing:

7. ☒ Please immediately start national examination procedures (35 U.S.C. 371 (f)).

8. ☐ **A copy of the International Application** as filed (35 U.S.C. 371(c)(2)) is transmitted herewith (file if in English but, if in foreign language, file only if not transmitted to PTO by the International Bureau) including:

a. ☐ Request;
b. ☐ Abstract;
c. _____ pgs. Spec. and Claims;
d. _____ sheet(s) Drawing which are ☐ informal ☐ formal of size ☐ A4 ☐ 11"

9. ☒ **A copy of the International Application has been transmitted by the International Bureau.**

10. **A translation of the International Application** into English (35 U.S.C. 371(c)(2))
a. ☒ is transmitted herewith including: (1) ☒ Request; (2) ☒ Abstract;
(3) 15 pgs. Spec. and Claims;
(4) 5 sheet(s) Drawing which are:
☐ informal ☒ formal of size ☒ A4 ☐ 11"
b. ☐ is not required, as the application was filed in English.
c. ☐ is not herewith, but will be filed when required by the forthcoming PTO Missing Requirements Notice per Rule 494(c) if box 4(a) is X'd or Rule 495(c) if box 4(b) is X'd.
d. ☐ Translation verification attached (not required now).

RE: USA National Filing of PCT/FI99/00247

11. ☒ **PLEASE AMEND** the specification before its first line by inserting as a separate paragraph:
a. ☒ --This application is the national phase of international application PCT/FI99/00247 filed March 25, 1999 which designated the U.S.--
b. ☐ --This application also claims the benefit of U.S. Provisional Application No. 60/ _____, filed _____.--

12. ☐ Amendments to the claims of the International Application **under PCT Article 19 (35 U.S.C. 371(c)(3)), i.e., before 18th month from first priority date above in item 3, are transmitted herewith (file only if in English) including:**

13. ☒ PCT Article 19 claim amendments (if any) have been transmitted by the International Bureau

14. ☐ Translation of the amendments to the claims **under PCT Article 19 (35 U.S.C. 371(c)(3)), i.e., of claim amendments** made before 18th month, **is attached (required by 20th month from the date in item 3 if box 4(a) above is X'd, or 30th month if box 4(b) is X'd, or else amendments will be considered canceled).**

15. **A declaration of the inventor** (35 U.S.C. 371(c)(4))
a. ☐ is submitted herewith ☐ Original ☐ Facsimile/Copy
b. ☒ is not herewith, but will be filed when required by the forthcoming PTO Missing Requirements Notice per Rule 494(c) if box 4(a) is X'd or Rule 495(c) if box 4(b) is X'd.

16. **An International Search Report (ISR):**
a. Was prepared by ☐ European Patent Office ☐ Japanese Patent Office ☒ Other
b. ☒ has been transmitted by the international Bureau to PTO.
c. ☒ copy herewith (2 pg(s).) ☒ plus Annex of family members (1 pg(s).).

17. **International Preliminary Examination Report** (IPER):
a. ☒ has been transmitted (if this letter is filed after 28 months from date in item 3) in English by the International Bureau with Annexes (if any) in original language.
b. ☒ copy herewith in English.
c.1 ☒ IPER Annex(es) in original language ("Annexes" are amendments made to claims/spec/drawings during Examination) including attached amended:
c.2 ☒ Specification/claim pages #12-15 claims # 1-28
Dwg Sheets #
d. ☒ Translation of Annex(es) to IPER **(required by 30th month due date, or else annexed amendments will be considered canceled).**

18. **Information Disclosure Statement** including:
a. ☒ Attached Form PTO-1449 listing documents
b. ☒ Attached copies of documents listed on Form PTO-1449
c. ☒ A concise explanation of relevance of ISR references is given in the ISR.

19. ☐ **Assignment** document and Cover Sheet for recording are attached. Please mail the recorded assignment document back to the person whose signature, name and address appear at the end of this letter.

20. ☐ Copy of Power to IA agent.

21. ☐ **Drawings** (complete only if 8d or 10a(4) not completed): ___ sheet(s) per set: ☐ 1 set informal; ☐ Formal of size ☐ A4 ☐ 11"

22. ☐ _____ (No.) **Verified Statement(s)** establishing "small entity" status under Rules 9 & 27

23. **Priority** is hereby claimed under 35 U.S.C. 119/365 based on the priority claim and the certified copy, both filed in the International Application during the international stage based on the filing in (country) FINLAND of:

	Application No.	Filing Date		Application No.	Filing Date
(1)	980704	27 MAR 1998	(2)		
(3)			(4)		
(5)			(6)		

a. ☒ See Form PCT/IB/304 sent to US/DO with copy of priority documents. If copy has not been received, please proceed promptly to obtain same from the IB.
b. ☐ Copy of Form PCT/IB/304 attached.

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24. Attached: FINNISH OFFICE ACTION AND NOTIFICATION OF THE RECORDING OF A CHANGE

25. **Preliminary Amendment:**

25.5 Per Item 17.c2, **cancel original** pages #_____, claims #_____, Drawing Sheets #

26. **Calculation of the U.S. National Fee (35 U.S.C. 371 (c)(1)) and other fees is as follows:**

Based on amended claim(s) per above item(s) ☐ 12, ☐ 14, ☒ 17, ☐ 25, ☐ 25.5 (hilite)

Total Effective Claims	28	minus 20 =	8	x $18/$9	= $	966/967
Independent Claims	2	minus 3 =	0	x $78/$39	= $	964/965
If any proper (ignore improper) Multiple Dependent claim is present,				add$260/$130	+	968/969

BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(4)): →→ **BASIC FEE REQUIRED, NOW** →→→→

A. If country code letters in item 1 are **not** "US","BR","BB","TT","MX","IL" "NZ", "IN" or "ZA"

See item 16 re:

1. Search Report was not prepared by EPO or JPO - - - - - - - - - add$970/$485 960/961
2. Search Report was prepared by EPO or JPO - - - - - - - - - - - add$840/$420 +970 970/971

SKIP B, C, D AND E UNLESS country code letters in item 1 are "US","BR","BB","TT","MX","IL", "NZ", "IN" or "ZA"

(X) → ☐ B. If USPTO did not issue both International Search Report (ISR) and (if box 4(b) above is X'd) the International Examination Report (IPER), - - - - - - - - - - - - - - - - - - add$970/$485 +0 960/961

(only) (one) → ☐ C. If USPTO issued ISR but not IPER (or box 4(a) above is X'd), - add$690/$345 +0 958/959

(these) 4) → ☐ D. If USPTO issued IPER but IPER Sec. V boxes not all 3 (boxes) YES, - add$670/$335 +0 956/957

→ ☐ E. If international preliminary examination fee was paid to USPTO and Rules 492(a)(4) and 496(b) satisfied (IPER Sec. V all 3 boxes YES for all claims), - - - - - - - - - - - - - add $96/$48 +0 962/963

27. **SUBTOTAL =** $970

28. If Assignment box 19 above is X'd, add Assignment Recording fee of ----$40 +0 (581)

29. Attached is a check to cover the - **TOTAL FEES** $970

Our Deposit Account No. 03-3975

Our Order No. 60256 (C#) | 273843 (M#)

CHARGE STATEMENT: The Commissioner is hereby authorized to charge any fee specifically authorized hereafter, or any missing or insufficient fee(s) filed, or asserted to be filed, or which should have been filed herewith or concerning any paper filed hereafter, and which may be required under Rules 16-18 and 492 (missing or insufficient fee only) now or hereafter relative to this application and the resulting Official document under Rule 20, or credit any overpayment, to our Account/Order Nos. shown above for which purpose a duplicate copy of this sheet is attached.

This CHARGE STATEMENT does not authorize charge of the issue fee until/unless an issue fee transmittal form is filed

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09/647081

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APPLICATION UNDER UNITED STATES PATENT LAWS

Atty. Dkt. No. PM 273843
(M#)

Invention: METHOD OF TRANSMITTING SYNCHRONIZED CHANNEL IN RADIO TANSMITTER

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This is a:

- ☐ Provisional Application
- ☐ Regular Utility Application
- ☐ Continuing Application
  - ☐ The contents of the parent are incorporated by reference
- ☒ PCT National Phase Application
- ☐ Design Application
- ☐ Reissue Application
- ☐ Plant Application
- ☐ Substitute Specification
  Sub. Spec Filed _____
  in App. No. _____/_____
- ☐ Marked up Specification re
  Sub. Spec. filed _____
  In App. No _____/_____

SPECIFICATION

METHOD OF TRANSMITTING SYNCHRONIZED CHANNEL IN RADIO TRANSMITTER

FIELD OF THE INVENTION

The invention relates to a method of transmitting a synchronized channel in a radio transmitter, where normal radio bursts are transmitted on a normal channel asynchronously.

BACKGROUND OF THE INVENTION

Cellular radio networks comprise applications which require that a subscriber terminal or some other corresponding radio receiver receives synchronized radio signals from various base stations. Such applications include different methods of locating subscriber terminals. An example of such locating methods is an OTD (Observed Time Difference) method based on time differences detected in the reception of signals. In this method a terminal equipment measures differences in times of arrivals of signals transmitted by base stations. The method requires that the base stations transmit signals at the same moment, in other words synchronously, or otherwise data is required on the differences in synchronization (Real Time Difference, RTD) between the base stations if the base stations are not synchronized. The location is carried out based on this data. This method is described in greater detail in Finnish Patent Application 954,705.

Several systems, such as the GSM system, are not synchronized or they are not synchronized sufficiently accurately so that the signals could be used in the location according to the OTD method. In the GSM system, normal channels are divided both on a time division (TDMA, time division multiple access) and frequency division (FDMA, frequency division multiple access) basis. A radio transmitter thus uses a specific time slot on a predetermined frequency for transmitting a normal physical channel. In the GSM system, the base stations transmit radio bursts of a normal channel asynchronously, which means that the transmissions between the base stations are not coordinated such that each base station would transmit a radio burst simultaneously. Further, the aforementioned synchronization differences between the base stations change over time. Therefore the OTD method cannot be used for location without continuous measurement of the synchronization differences. Measurement of the synchronization differences produces more signalling and causes additional error in the accuracy of the location.

One suggested solution is to synchronize all the radio transmitters with each other by means of a satellite-based locating system (global positioning system, GPS), in which case a GPS receiver would be installed at each base station. This arrangement may cause problems in the GSM system since the system utilizes hierarchical clocks. This means that a base station controller guiding a base station obtains timing from higher network elements and delivers it to the base stations. If a GPS receiver were used for the timing of the base station transmission, the entire timing of the GSM system would be confused.

BRIEF DESCRIPTION OF THE INVENTION

An object of the invention is to develop a method and an apparatus implementing the method which solve the aforementioned problems. This is achieved with a method of the type described in the introduction, which is characterized by obtaining synchronized timing; forming synchronized radio bursts, the length of which is at most half of the length of a normal radio burst; transmitting a synchronized radio burst in the place of a normal radio burst such that the transmission of the synchronized radio burst is synchronized with the obtained synchronized timing.

The invention also relates to a radio transmitter comprising a channel codec for forming a normal channel; a burst former for forming normal radio bursts; a multiplexer for assigning to each burst the moment for its transmission.

The radio transmitter according to the invention is characterized in that it also comprises a clock for obtaining synchronized timing; the channel codec is arranged to form a synchronized channel; the burst former is arranged to form synchronized radio bursts, the length of which is at most half of the length of a normal radio burst; the multiplexer is arranged to insert a synchronized radio burst in the place of a normal radio burst such that the transmission of the synchronized radio burst is synchronized with the obtained synchronized timing.

The preferred embodiments of the invention are disclosed in the dependent claims.

A basic idea of the invention is that a radio burst normally used by a radio transmitter is at least halved so that the obtained synchronized radio burst can always be inserted flexibly in the place of the normal radio burst. The expression 'in the place of' means that the normal radio burst is replaced in

principle, i.e. the burst that is to be actually transmitted is not necessarily replaced but the synchronized burst is transmitted during the time slot in which it would be possible in principle to transmit the normal radio burst.

The method and the radio transmitter according to the invention provide several advantages. Synchronized signals can be transmitted to a receiver without a need to make any changes in the general timing structure. For example the GSM system does not require changes in the TDMA frame structure. The structure of the synchronized signals can be optimized according to the needs of the intended use, such as a locating method.

BRIEF DESCRIPTION OF THE FIGURES

In the following the invention will be described in greater detail in connection with preferred embodiments, with reference to the accompanying drawings, in which

Figure 1 shows an example of the structure of a cellular radio network employing the invention,

Figure 2 shows the structure of a transceiver,

Figure 3 shows synchronized radio bursts according to the invention and the moments when they are transmitted at four different base stations,

Figure 4 shows two different alternatives of transmitting a synchronized radio burst in the place of a normal radio burst,

Figure 5 shows the structure of a synchronized radio burst,

Figures 6 and 7 are flowcharts illustrating the implementation of the method according to the invention,

Figure 8 shows the positioning of a synchronized radio burst with padding bits in the place of a normal radio burst.

DETAILED DESCRIPTION OF THE INVENTION

The invention can be used in different radio transmitters. The examples describe the use of the invention in a cellular radio network. With reference to Figure 1, the structure of a typical cellular radio network will be described. Figure 1 only contains the blocks that are essential for explaining the invention, but it is clear for those skilled in the art that a conventional cellular radio network also comprises other functions and structures, which do not have to be described in greater detail herein. The examples describe a

cellular radio network employing time division multiple access (TDMA) without restricting the invention thereto, however.

A cellular radio network typically comprises a fixed network infrastructure, i.e. a network part 128, and subscriber terminals 150, which may be fixed, located in a vehicle or portable hand-held terminal equipments. The network part 128 comprises base stations 100. Several base stations 100 are controlled in a centralized manner by a base station controller 102 communicating with them. A base station 100 comprises transceivers 114. A base station 100 typically comprises 1 to 16 transceivers 114. For example in the TDMA radio system, one transceiver 114 typically provides radio capacity for one TDMA frame, i.e. eight time slots.

The base station 100 comprises a control unit 118, which controls the operation of the transceivers 114 and a multiplexer 116. The multiplexer 116 places the traffic and control channels used by several transceivers 114 onto a single transmission link 160.

The transceivers 114 of the base station 100 have a connection to an antenna unit 112, which realizes a bidirectional radio link 170 to a subscriber terminal 150. The structure of frames to be transmitted on the bidirectional radio link 170 is accurately determined and it is referred to as an air interface.

Figure 2 shows in greater detail the structure of a transceiver 114. The functions at the reception will be described first. A receiver 200 comprises a filter blocking frequencies outside a desired frequency band. A signal is thereafter converted onto an intermediate frequency or directly to baseband, and the signal in this form is sampled and quantized in an A/D converter 202.

An equalizer 204 compensates for interference caused by multipath propagation, for example. A demodulator 206 extracts from the equalized signal a bit stream, which is transferred to a demultiplexer 208. The demultiplexer 208 separates the desired part from the received bit stream into logical channels. This function is based on the structure of the received bit stream, which consists of radio bursts placed in time slots, forming a physical channel.

A channel codec 216 decodes bit streams of different logical channels, i.e. it decides whether a bit stream consists of signalling data, which is transmitted to a control unit 214, or speech, which is transmitted 240 to a speech codec 122 in the base station controller 102. The channel codec 216

decodes possible channel coding, such as block coding and convolutional coding, deinterleaves possible interleaving, and decrypts the encryption used over the radio path.

The control unit 214 carries out internal control tasks by controlling different units mainly on the basis of control received from the base station controller 102.

The functions at the transmission will be described next. The data to be transmitted is channel-coded, interleaved and encrypted in the channel codec 216. A burst former 228 adds a training sequence and a tail to the data arriving from the channel codec 216. A multiplexer 226 assigns to each burst its physical channel. A modulator 224 modulates digital signals onto a radio frequency carrier. This function is analogous, wherefore it requires a D/A converter 222.

A transmitter 220 comprises a filter restricting the bandwidth. The transmitter 220 also controls the output power of the transmission. A synthesizer 212 provides different units with required frequencies. The synthesizer 212 comprises a clock, which may be locally controlled or controlled in a centralized manner from some other place, for example the base station controller 102. The synthesizer 212 creates the necessary frequencies by means of a voltage-controlled oscillator, for example.

As shown in Figure 2, the structure of the transceiver can further be divided into radio-frequency parts 230 and a digital signal processor with its software 232. The radio-frequency parts 230 comprise the receiver 200, the transmitter 220 and the synthesizer 212. The digital signal processor with its software 232 comprises the equalizer 204, the demodulator 206, the demultiplexer 208, the channel codec 216, the control unit 214, the burst former 228, the multiplexer 226 and the modulator 224. Conversion of an analogue radio signal into a digital signal requires an A/D converter 202 and, correspondingly, the conversion of a digital signal into an analogue signal requires a D/A converter 222.

The base station controller 102 comprises a group switching field 120 and a control unit 124. The group switching field 120 is used for switching speech and data and for connecting signalling circuits. The base station 100 and the base station controller 102 form a base station system 126, which also comprises a transcoder 122. The distribution of functions between the base station controller 102 and the base station 100 as well as their physical

structure may vary in different implementations. The base station 100 typically manages the implementation of the radio path as described above. The base station controller 102 typically manages the following things: configuration of traffic channels, frequency hopping control, paging of subscriber terminals, power control, quality control of active channels, and handover control.

The transcoder 122 is usually located as close to a mobile services switching centre 132 as possible, because this allows speech to be transmitted between the transcoder 122 and the base station controller 102 in a cellular radio network form, which saves transmission capacity. The transcoder 122 converts different digital speech coding modes used between a public switched telephone network and a radio phone network to make them compatible, for example from a 64 kbit/s fixed network form to another form (such as 13 kbit/s) of the cellular radio network, and vice versa. The control unit 124 performs call control, mobility management, gathering of statistical data, and signalling.

As shown in Figure 1, a circuit-switched connection can be set up from the subscriber terminal 150 to a telephone 136 connected to the public switched telephone network (PSTN) 134 via the mobile services switching centre 132. The cellular radio network may also employ a packet-switched connection, for example 2+ phase packet transmission, i.e. GPRS (General Packet Radio Service), of the GSM system.

The structure of the subscriber terminal 150 can be described by means of the representation of the structure of the transceiver 114 shown in Figure 2. The structural elements of the subscriber terminal 150 are functionally identical to those of the transceiver 114. The subscriber terminal 150 also comprises a duplex filter between the antenna 112 and the receiver 200 and the antenna and the transmitter 220, user interface parts and a speech codec. The speech codec is connected to the channel codec 216 via a bus 240.

Figure 3 shows how transmissions of four different base stations BTS 1, BTS 2, BTS 3, BTS 4 are not synchronized with each other. Each base station transmits its normal bursts NB at instants that differ randomly from one another. According to the invention, each base station receives timing, which is described in Figure 3 by successive bursts SYNCHRONIZED BURSTS. Timing is received from a clock, which is for example a GPS receiver 180

connected to the control unit 118 of the base station 100 as shown in Figure 1. The control unit 118 forwards the received timing to the transceivers 114.

In the invention, a special synchronous channel is formed in the channel codec 216. In principle the synchronous channel is placed on a normal physical channel. The number of physical channels available is a compromise. For example in the OTD locating method, the more frequently synchronous signals are transmitted the more often the subscriber terminal 150 is able to receive them and to carry out more measurements, which improves the accuracy of the location. On the other hand, this consumes more traffic capacity of the system. The example shown in Figure 3 utilizes one frequency, i.e. all the eight time slots of one TDMA frame, i.e. eight physical traffic channels. If the traffic capacity is to be consumed as little as possible, only one time slot can be used to transmit synchronized bursts, for example time slot 'one' of a broadcast control channel (BCCH), in which case the subscriber terminal 150 always knows the location of the synchronized bursts after it has received one normal synchronization channel burst (SCH). In order that the capacity of an uplink physical channel corresponding to a downlink synchronized channel would not be wasted, the capacity can be used to forward signalling data, such as measurement results of the subscriber terminal 150, to the base station 100.

A preferred embodiment utilizes the normally unused capacity for transmission of synchronized radio bursts. For example when a radio transmitter is in a mode of discontinuous transmission (DTX) and no normal radio bursts are being transmitted, it is possible to transmit instead synchronized radio bursts, on the basis of which the subsicber terminal 150 is able to determine its location, for example.

Another method of making the operation more effective is to transmit synchronized radio bursts by means of only a part of the capacity of a physical channel. In such a situation the synchronous bursts are repeated according to a predetermined sequence, for example in every third time slot of the physical channel.

The physical channel to be used for transmitting the synchronized channel can be indicated to the subscriber terminal 150 on a control channel, such as the broadcast control channel (BCCH).

The burst former 228 is arranged to form synchronized radio bursts SB. The length of a synchronized radio burst SB is at most half of the

length of a normal burst NB in order that the synchronized burst SB can always be inserted in the place of the normal burst NB. The multiplexer 226 is arranged to insert the synchronized radio burst SB in the place of the normal radio burst NB in such a way that the transmission of the synchronized burst SB is synchronized with the timing obtained from the clock 180.

Figure 3 shows timing in the form of possible synchronized bursts SYNCHRONIZED BURSTS. A vertical line has been drawn from the start and end of each such burst to describe the instant a synchronous burst SB can be transmitted at each base station BTS 1 TIMING, BTS 2 TIMING, BTS 3 TIMING, BTS 4 TIMING. The synchronized bursts SB transmitted by each base station start and end at exactly the same instant.

It can be seen from Figure 3 that in a preferred embodiment the timings happen to match at base station BTS 1, whereupon two synchronized bursts SB can be transmitted in the place of a normal burst NB. The burst former 228 is arranged to form successive synchronized bursts SB, which the multiplexer 226 inserts in the place of the normal burst NB since they fit there. On the other hand, this embodiment can also be avoided if receiving two synchronized bursts during one time slot causes problems in the subscriber terminal 150, in which case only one of the synchronized bursts is transmitted.

At base station BTS 2, the timings differ from one another exactly half a time slot, and therefore it is possible to transmit two synchronized bursts SB in the place of the normal burst NB.

However, in the most common situation the timing obtained by the base station 100 from the network and the timing obtained from the clock 180 do not match. In such a case it is possible to transmit only one synchronized burst SB in the place of the normal burst NB as shown in Figure 3 with base stations BTS 3 and BTS 4. As the figure shows, every other synchronous burst SB would extend to two normal bursts NB, which is not desirable.

Figure 5 illustrates the structure of a synchronized burst SB. In the same way as a normal burst a synchronized burst must also comprise tail bits TB both at the beginning and end of the burst. These bits are used during a guard period when the transmitter increases the power to the required transmit power and thereafter lowers it to the idle state. The tail bits are usually set to zero.

As shown in Figure 4, a synchronized burst SB can be inserted in the place of a normal burst NB in two different manners. The first manner is

shown in the middle in the figure. The synchronized burst SB shown therein is a special burst of Figure 5, the length of which is at most half of the normal burst NB. Nothing else is transmitted in this time slot besides the synchronized burst SB.

The second manner is illustrated in Figure 4 at the bottom. The burst former 228 is arranged to form a burst that is equal in length to a normal radio burst NB, and a synchronized burst SB is inserted therein. The part of the formed burst that does not belong to the synchronized burst SB is filled with predetermined padding bits PAD. This embodiment provides an advantage that the transmission time of the burst does not have to be changed, but only the content thereof is altered.

As shown in Figure 5, the synchronized burst SB comprises at least a predetermined bit pattern TS. Usually this bit pattern is a training sequence which is also known to the receiver and which can be searched in the equalizer 204. By comparing this known training sequence to the signal that is actually received it is possible to estimate what kind of distortions have accumulated in the signal over the radio path. When the receiver receives the synchronized burst SB it also obtains accurate timing, since the transmission moment of the burst is determined to be the same at different base stations, unlike in the case of normal bursts NB. For the purpose of locating methods the structure of a known bit pattern can be optimized suitably.

In a preferred embodiment a synchronized burst also comprises other information INFO as shown in Figure 5. The information may contain the location coordinates COORD of the base station 100. Timing offset OFFSET can also be transmitted in the information field INFO. In this case the offset refers to the time difference between the transmission moments of the ideal synchronized radio burst and the actual synchronized radio burst. In reality, the transmission moment of the synchronized burst SB can be adjusted with the accuracy of maybe only one bit or one fourth of a bit, in which case the offset indicates the difference from the exact correct transmission moment. The information may further include other information OTHER INFO, and the information can also be combined COORD + OFFSET in a desired manner.

To obtain the most accurate possible timing the training sequence TS should be as long as possible. Therefore some or even all of the information INFO can be transferred to padding bits PAD, so that the training sequence TS can be continued to the place of the information INFO. Since the

position of the synchronized burst SB varies, sometimes the information INFO would be placed before and sometimes after the synchronized burst SB. In such a case the subscriber terminal 150 must be able to select the correct place from which the information INFO is decoded.

Figure 8 shows how a synchronized radio burst SB is inserted with padding bits PAD in the place of a normal radio burst NB. This figure illustrates the implementation of the alternative shown lowermost in Figure 4. The tail bits TB are naturally situated at the beginning and end of the burst. They are followed by padding bits PAD, which surround the training sequence TS and the information INFO.

The invention is preferably implemented by means of software and it requires changes in an accurately restricted area of the software of the digital signal processor 232 in the transceiver 114 of the base station 100. The invention further requires that a radio transmitter obtains synchronized timing for example from the clock 180.

The implementation of the method according to the invention in a radio transmitter is further illustrated with reference to the flowcharts of Figures 6 and 7. The method starts in block 600. In block 602 the method proceeds to the next time slot. In block 604 it is checked whether the logical channel to be transmitted in the time slot is normal or synchronized. In block 606 normal radio bursts are transmitted asynchronously on a normal channel. In block 608, a synchronized burst formed according to the invention is transmitted. In block 610 it is checked whether the method is to be continued. If not, the execution of the method is terminated in block 612. If it is continued, the process proceeds to block 602, where the processing of the next time slot is started.

Block 608 is described in greater detail in Figure 7. The implementation begins in block 700. Synchronized timing is obtained in block 702. Next, it is checked in block 704 whether it is time to transmit a synchronized burst. If not, the process moves back to block 702 where the clock is checked. This is repeated until it is time to transmit the synchronized burst. When it is detected after the checking carried out in block 704 that it is time to transmit a synchronized burst, the method proceeds to block 706. In block 706 it is checked whether a sufficient part of the time slot is left for the transmission of the synchronized burst. If not, the method proceeds to block 712. If a sufficient part of the time slot is left, the process moves to block 708

where synchronized radio bursts SB are formed, the bursts having a length of at most half of the length of a normal radio burst. Next, in block 710 the synchronized radio burst is transmitted in the place of a normal radio burst such that the transmission of the synchronized burst is synchronized with the obtained synchronized timing. The last step is block 712 where the execution of block 608 is terminated.

Even though the invention is described above with reference to the example according to the accompanying drawings, it is clear that the invention is not restricted thereto but it can be modified in several ways within the scope of the inventive idea disclosed in the appended claims.

CLAIMS 10.5.2000

1. A method of transmitting synchronized channels in at least two radio transmitters, where normal radio bursts are transmitted (606) on a normal channel asynchronously, **characterized** by

(702) obtaining synchronized timing;

(708) forming synchronized radio bursts (SB), the length of which is at most half of the length of a normal radio burst;

(710) transmitting synchronized radio bursts in the place of normal radio bursts such that the transmission of the synchronized radio bursts is synchronized with the obtained synchronized timing.

2. A method according to claim 1, **characterized** by forming at least two successive synchronous radio bursts (SB), at least one of which is transmitted.

3. A method according to claim 1, **characterized** by placing at least one synchronized radio burst (SB) in a burst having the length of a normal radio burst.

4. A method according to claim 3, **characterized** in that the part of the burst that does not belong to the synchronized radio burst (SB) consists of predetermined padding bits (PAD).

5. A method according to claim 1, **characterized** in that the synchronized radio burst (SB) comprises a predetermined bit pattern (TS).

6. A method according to claim 5, **characterized** in that the bit pattern is a training sequence.

7. A method according to claim 1, **characterized** in that the synchronized radio burst (SB) comprises information (INFO), such as the location coordinates (COORD) of the radio transmitted and/or the offset (OFFSET), i.e. the time difference between the transmission moments of the ideal synchronized radio burst and the actual synchronous radio burst.

8. A method according to claim 1, **characterized** by placing the radio burst in a time slot.

9. A method according to claim 1, **characterized** in that the synchronized channel is transmitted by means of at least one normal physical channel.

10. A method according to claim 9, **characterized** by indicating on a control channel the physical channels to be used for the transmission of the synchronized channel.

11. A method according to claim 1, **characterized** in that the physical channels in the direction of reception corresponding to the synchronous channel in the direction of transmission are used to transmit signalling information, such as measurement results.

12. A method according to claim 1, **characterized** in that the method is used in a locating method, such as the OTD (observed time difference) method.

13. A method according to claim 1, **characterized** in that a synchronized radio burst is transmitted when the radio transmitter is in discontinuous transmission.

14. A method according to claim 1, **characterized** in that the transmission of synchronized radio bursts only employs a part of the capacity of a normal channel.

15. A radio transmitter comprising:

a channel codec (216) for forming a normal channel;

a burst former (228) for forming normal radio bursts;

a multiplexer (226) for assigning to each burst the moment for its transmission;

characterized in that

it also comprises a clock (180) for obtaining synchronized timing, which synchronized timing defines the coordination between the transmission of radio bursts from at least two different base stations (100) comprising each at least one radio transmitter;

the channel codec (216) is arranged to form a synchronized channel;

the burst former (228) is arranged to form synchronized radio bursts (SB), the length of which is at most half of the length of a normal radio burst;

the multiplexer (226) is arranged to insert a synchronized radio burst in the place of a normal radio burst such that the transmission of the synchronized radio burst is synchronized with the obtained synchronized timing.

16. A radio transmitter according to claim 15, **characterized** in that the burst former (228) is arranged to form at least two successive synchronous radio bursts (SB) and the multiplexer (226) is arranged to insert at least one of them in the place of a normal radio burst.

17. A radio transmitter according to claim 15, **characterized** in that the burst former (228) is arranged to form a burst the length of which equals the length of a normal radio burst and which comprises at least one synchronized radio burst (SB).

18. A radio transmitter according to claim 17, **characterized** in that the burst former (228) is arranged to place predetermined padding bits (PAD) in the part of the burst that does not belong to the synchronized radio burst (SB).

19. A radio transmitter according to claim 15, **characterized** in that the burst former (228) is arranged to place a predetermined bit pattern (TS) in the synchronized radio burst (SB).

20. A radio transmitter according to claim 19, **characterized** in that the bit pattern is a training sequence.

21. A radio transmitter according to claim 15, **characterized** in that the channel codec (216) is arranged to place in the synchronized radio burst (SB) information, such as the location coordinates (COORD) of the radio transmitter and/or the offset (OFFSET), i.e. the time difference between the transmission moments of the ideal synchronized radio burst and the actual synchronous radio burst.

22. A radio transmitter according to claim 15, **characterized** in that the multiplexer (226) is arranged to place the radio burst in a time slot.

23. A radio transmitter according to claim 15, **characterized** in that the channel codec (216) is arranged to use at least one normal physical channel for the synchronized channel.

24. A radio transmitter according to claim 23, **characterized** in that the radio transmitter is arranged to indicate on a control channel the physical channels to be used for the transmission of the synchronized channel.

25. A radio transmitter according to claim 15, **characterized** in that the radio transmitter is arranged to receive signalling data, such as measurement results, from the channels in the direction of reception corresponding to the synchronous channels in the direction of transmission.

26. A radio transmitter according to claim 15, **characterized** in that the clock (180) is a GPS receiver.

27. A radio transmitter according to claim 15, **characterized** in that the radio transmitter is arranged to transmit a synchronized radio burst when the transmitter is in discontinuous transmission.

28. A radio transmitter according to claim 15, **characterized** in that the radio transmitter is arranged to use only a part of the capacity of a normal channel for the transmission of synchronized radio bursts.

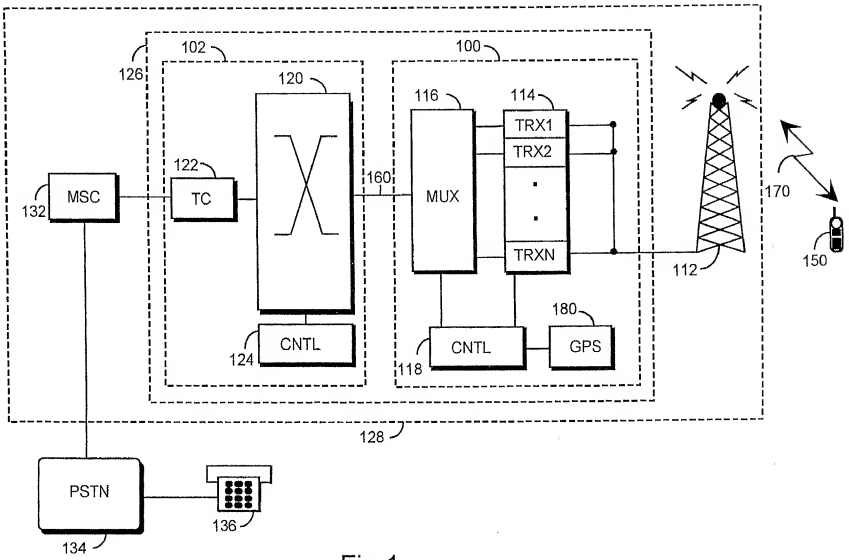

Fig 1

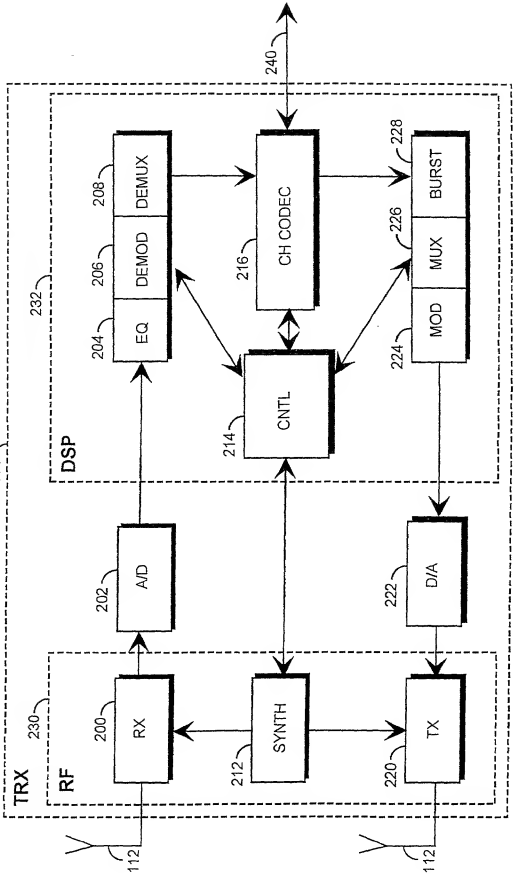
TRX
114
RF
230
DSP
232
200
RX
212
SYNTH
220
TX
202
A/D
222
D/A
204
EQ
206
DEMOD
208
DEMUX
214
CNTL
216
CH CODEC
224
MOD
226
MUX
228
BURST
240
112
112

Fig 2

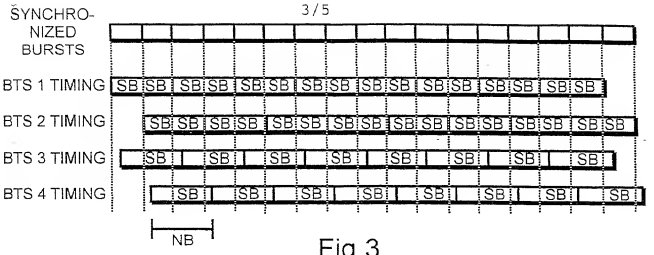

Fig 3

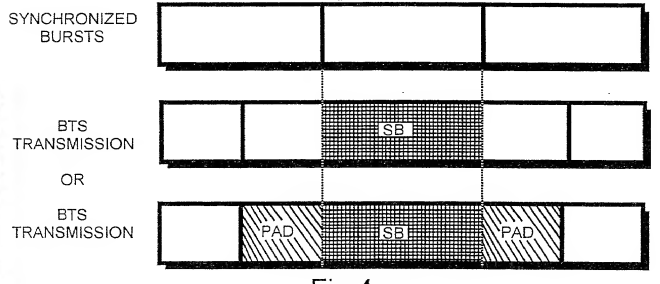

Fig 4

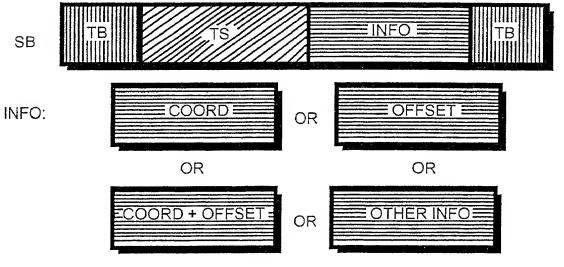

Fig 5

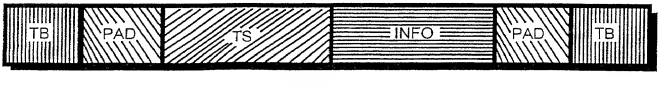

Fig 8

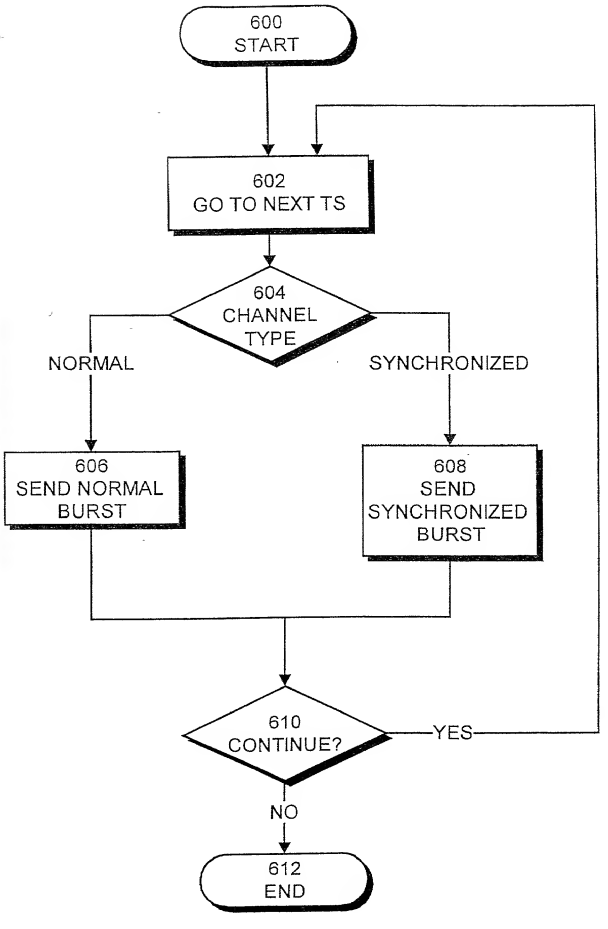
600
START
602
GO TO NEXT TS
604
CHANNEL
TYPE
NORMAL
SYNCHRONIZED
606
SEND NORMAL
BURST
608
SEND
SYNCHRONIZED
BURST
610
CONTINUE?
YES
NO
612
END

Fig 6

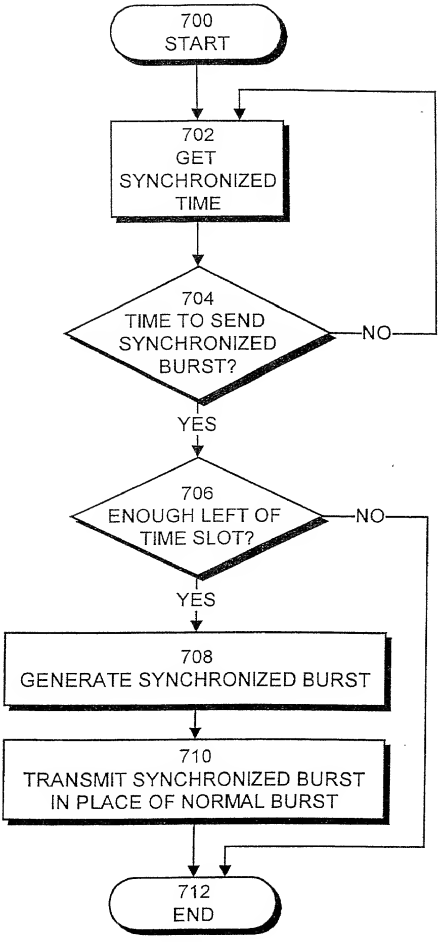
700
START
702
GET
SYNCHRONIZED
TIME
704
TIME TO SEND
SYNCHRONIZED
BURST?
NO
YES
706
ENOUGH LEFT OF
TIME SLOT?
NO
YES
708
GENERATE SYNCHRONIZED BURST
710
TRANSMIT SYNCHRONIZED BURST
IN PLACE OF NORMAL BURST
712
END

Fig 7

FOR UTILITY/DESIGN
CIP/PCT NATIONAL/PLANT
ORIGINAL/SUBSTITUTE/SUPPLEMENTAL
DECLARATIONS

RULE 63 (37 C.F.R. 1.63)
DECLARATION AND POWER OF ATTORNEY
FOR PATENT APPLICATION
IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

PM & S
FORM

As a below named inventor, I hereby declare that my residence, post office address and citizenship are as stated below next to my name, and I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the **INVENTION ENTITLED**

Method of transmitting synchronized channel in radio transmitter

the specification of which (CHECK applicable BOX(ES))

X → A. ☐ is attached hereto.

BOX(ES) → B. ☐ was filed on _____ as U.S. Application No. _____ /

→ C. ☒ was filed as PCT International Application No. PCT/ FI99 / 00247 on 25 March 1999

and (if applicable to U.S. or PCT application) was amended on 10 May 2000

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose all information known to me to be material to patentability as defined in 37 C.F.R. 1.56. I hereby claim foreign priority benefits under 35 U.S.C. 119(a)-(d) or 365(b) of any foreign application(s) for patent or inventor's certificate, or 365(a) of any PCT International Application which designated at least one other country than the United States, listed below and have also identified below any foreign application for patent or inventor's certificate, or PCT International Application, filed by me or my assignee disclosing the subject matter claimed in this application and having a filing date (1) before that of the application on which priority is claimed, or (2) if no priority claimed, before the filing date of this application:

PRIOR FOREIGN APPLICATION(S) Number	Country	Day/MONTH/Year Filed	Date first Laid-open or Published	Date Patented or Granted	Priority Claimed Yes	No
980704	Finland	27 March 1998			X	

I hereby claim domestic priority benefit under 35 U.S.C. 119(e) or 120 and 365(c) of the indicated United States applications listed below and PCT international applications listed above or below and, if this is a continuation-in-part (CIP) application, insofar as the subject matter disclosed and claimed in this application is in addition to that disclosed in such prior applications, I acknowledge the duty to disclose all information known to me to be material to patentability as defined in 37 C.F.R. 1.56 which became available between the filing date of each such prior application and the national or PCT international filing date of this application:

PRIOR U.S. PROVISIONAL, NONPROVISIONAL AND/OR PCT APPLICATION(S) Application No. (series code/serial no.)	Day/MONTH/Year Filed	Status pending, abandoned, patented	Priority Claimed Yes	No

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

And I hereby appoint Pillsbury Madison & Sutro LLP, Intellectual Property Group, 1100 New York Avenue, N.W., Ninth Floor, East Tower, Washington, D.C. 20005-3918, telephone number (202) 861-3000 (to whom all communications are to be directed), and the below-named persons (of the same address) individually and collectively my attorneys to prosecute this application and to transact all business in the Patent and Trademark Office connected therewith and with the resulting patent, and I hereby authorize them to delete names/numbers below of persons no longer with their firm and to act and rely on instructions from and communicate directly with the person/assignee/attorney/firm/ organization who/which first sends/sent this case to them and by whom/which I hereby declare that I have consented after full disclosure to be represented unless/until I instruct the above Firm and/or a below attorney in writing to the contrary.

Paul N. Kokulis	16773	Dale S. Lazar	28872	Mark G. Paulson	30793	Michael R. Dzwonczyk	36787
Raymond F. Lippitt	17519	Paul E. White, Jr.	32011	Stephen C. Glazier	31361	W. Patrick Bengtsson	32456
G. Lloyd Knight	17698	Glenn J. Perry	28458	Paul F. McQuade	31642	Jack S. Barufka	37087
Carl G. Love	18781	Kendrew H. Colton	30368	Ruth N. Morduch	31044	Adam R. Hess	41835
Kevin E. Joyce	20508	G. Paul Edgell	24238	Richard H. Zaitlen	27248		
George M. Sirilla	18221	Lynn E. Eccleston	35861	Roger R. Wise	31204		
Donald J. Bird	25323	Timothy J. Klima	34852	Jay M. Finkelstein	21082		
Peter W. Gowdey	25872	David A. Jakopin	32995	Anita M. Kirkpatrick	32617		

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	City	State/Foreign Country	Country of Citizenship
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(FOR ADDITIONAL INVENTORS, check box ☒ to attach PAT 116-2 same information for each re signature, name, date, citizenship, residence and address.)

RE: USA National Filing of PCT/FI99/00247

11. ☒ **PLEASE AMEND** the specification before its first line by inserting as a separate paragraph:
a. ☒ --This application is the national phase of international application PCT/FI99/00247 filed March 25, 1999 which designated the U.S.--
b. ☐ --This application also claims the benefit of U.S. Provisional Application No. 60/ _____, filed _____ .--

12. ☐ Amendments to the claims of the International Application **under PCT Article 19 (35 U.S.C. 371(c)(3)), i.e., before 18th month from first priority date above in item 3, are transmitted herewith (file only if in English) including:**

13. ☒ PCT Article 19 claim amendments (if any) have been transmitted by the International Bureau

14. ☐ Translation of the amendments to the claims **under PCT Article 19 (35 U.S.C. 371(c)(3)), i.e., of claim amendments** made before 18th month, **is attached (required by 20th month from the date in item 3 if box 4(a) above is X'd, or 30th month if box 4(b) is X'd, or else amendments will be considered canceled).**

15. **A declaration of the inventor** (35 U.S.C. 371(c)(4))
a. ☐ is submitted herewith ☐ Original ☐ Facsimile/Copy
b. ☒ is not herewith, but will be filed when required by the forthcoming PTO Missing Requirements Notice per Rule 494(c) if box 4(a) is X'd or Rule 495(c) if box 4(b) is X'd.

16. **An International Search Report (ISR):**
a. Was prepared by ☐ European Patent Office ☐ Japanese Patent Office ☒ Other
b. ☒ has been transmitted by the international Bureau to PTO.
c. ☒ copy herewith (2 pg(s).) ☒ plus Annex of family members (1 pg(s).).

17. **International Preliminary Examination Report (IPER):**
a. ☒ has been transmitted (if this letter is filed after 28 months from date in item 3) in English by the International Bureau with Annexes (if any) in original language.
b. ☒ copy herewith in English.
c.1 ☒ IPER Annex(es) in original language ("Annexes" are amendments made to claims/spec/drawings during Examination) including attached amended:
c.2 ☒ Specification/claim pages #12-15 claims # 1-28
Dwg Sheets #
d. ☒ Translation of Annex(es) to IPER **(required by 30th month due date, or else annexed amendments will be considered canceled).**

18. **Information Disclosure Statement** including:
a. ☒ Attached Form PTO-1449 listing documents
b. ☒ Attached copies of documents listed on Form PTO-1449
c. ☒ A concise explanation of relevance of ISR references is given in the ISR.

19. ☐ **Assignment** document and Cover Sheet for recording are attached. Please mail the recorded assignment document back to the person whose signature, name and address appear at the end of this letter.

20. ☐ Copy of Power to IA agent.

21. ☐ **Drawings** (complete only if 8d or 10a(4) not completed): ___ sheet(s) per set: ☐ 1 set informal; ☐ Formal of size ☐ A4 ☐ 11"

22. ☐ _____ (No.) **Verified Statement(s)** establishing "small entity" status under Rules 9 & 27

23. **Priority** is hereby claimed under 35 U.S.C. 119/365 based on the priority claim and the certified copy, both filed in the International Application during the international stage based on the filing in (country) FINLAND of:

	Application No.	Filing Date		Application No.	Filing Date
(1)	980704	27 MAR 1998	(2)		
(3)			(4)		
(5)			(6)		

a. ☒ See Form PCT/IB/304 sent to US/DO with copy of priority documents. If copy has not been received, please proceed promptly to obtain same from the IB.
b. ☐ Copy of Form PCT/IB/304 attached.

RE: USA National Filing of PCT/FI99/00247

534 Rec'd PCT/PTO 26 SEP 2000

24. Attached: FINNISH OFFICE ACTION AND NOTIFICATION OF THE RECORDING OF A CHANGE

25. **Preliminary Amendment:**

25.5 Per Item 17.c2, **cancel original** pages #_____, claims #_____, Drawing Sheets #

26. **Calculation of the U.S. National Fee (35 U.S.C. 371 (c)(1)) and other fees is as follows:**

Based on amended claim(s) per above item(s) ☐ 12, ☐ 14, ☒ 17, ☐ 25, ☐ 25.5 (hilite)

Total Effective Claims	28	minus 20 =	8	x $18/$9	=	$	966/967
Independent Claims	2	minus 3 =	0	x $78/$39	=	$	964/965
If any proper (ignore improper) Multiple Dependent claim is present,				add$260/$130	+		968/969

BASIC NATIONAL FEE (37 CFR 1.492(a)(1)-(4)): →→ **BASIC FEE REQUIRED, NOW** →→→→

A. If country code letters in item 1 are **not** "US","BR","BB","TT","MX","IL" "NZ", "IN" or "ZA"

See item 16 re:

1. Search Report was not prepared by EPO or JPO ---------- add$970/$485 960/961
2. Search Report was prepared by EPO or JPO ---------- add$840/$420 +970 970/971

SKIP B, C, D AND E UNLESS country code letters in item 1 are "US","BR","BB","TT","MX","IL", "NZ", "IN" or "ZA"

(X) → ☐ B. If USPTO did not issue both International Search Report (ISR) and (if box 4(b) above is X'd) the International Examination Report (IPER), ---------- add$970/$485 +0 960/961

(only) (one) of (these) (2) (boxes) → ☐ C. If USPTO issued ISR but not IPER (or box 4(a) above is X'd), ---------- add$690/$345 +0 958/959

(2) → ☐ D. If USPTO issued IPER but IPER Sec. V boxes not all 3 YES, ---------- add$670/$335 +0 956/957

→ ☐ E. If international preliminary examination fee was paid to USPTO and Rules 492(a)(4) and 496(b) satisfied (IPER Sec. V all 3 boxes YES for all claims), ---------- add $96/$48 +0 962/963

27. **SUBTOTAL =** $970

28. If Assignment box 19 above is X'd, add Assignment Recording fee of ----$40 +0 (581)

29. Attached is a check to cover the ---------- **TOTAL FEES** $970

Our Deposit Account No. 03-3975

Our Order No. 60256 (C#) | 273843 (M#)

CHARGE STATEMENT: The Commissioner is hereby authorized to charge any fee specifically authorized hereafter, or any missing or insufficient fee(s) filed, or asserted to be filed, or which should have been filed herewith or concerning any paper filed hereafter, and which may be required under Rules 16-18 and 492 (missing or insufficient fee only) now or hereafter relative to this application and the resulting Official document under Rule 20, or credit any overpayment, to our Account/Order Nos. shown above for which purpose a duplicate copy of this sheet is attached.

This CHARGE STATEMENT does not authorize charge of the issue fee until/unless an issue fee transmittal form is filed

Pillsbury Madison & Sutro LLP
Intellectual Property Group

1100 New York Avenue, NW
Ninth Floor
Washington, DC 20005-3918
Tel: (202) 861-3000
Atty/Sec: RCI/sdm

By Atty: Richard C. Irving **Reg. No.** 38499

Sig: Richard C. Irving **Fax:** (202) 822-0944 **Tel:** (202) 861-3788

NOTE: File in duplicate with 2 postcard receipts (PAT-103) & attachments.

DECLARATION AND POWER OF ATTORNEY

(continued)

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(6) INVENTOR'S SIGNATURE: **Date:**

First	Middle Initial	Family Name

Residence	City	State/Foreign Country	Country of Citizenship

Post Office Address (include Zip Code)	

(7) INVENTOR'S SIGNATURE: **Date:**

First	Middle Initial	Family Name

Residence	City	State/Foreign Country	Country of Citizenship

Post Office Address (include Zip Code)	

(8) INVENTOR'S SIGNATURE: **Date:**

First	Middle Initial	Family Name

Residence	City	State/Foreign Country	Country of Citizenship

Post Office Address (include Zip Code)	

(9) INVENTOR'S SIGNATURE: **Date:**

First	Middle Initial	Family Name

Residence	City	State/Foreign Country	Country of Citizenship

Post Office Address (include Zip Code)	